

Final Report

**Conversion Factors for
Individual Material Types**

Submitted to

California Integrated Waste Management Board

by

CalRecovery
INCORPORATED

Teilus Institute

ACT...now

106
C3
C6
1991
93005398

December 1991

RESULTS

Table 5 is the master table that presents conversion factors for weight-to-volume and volume-to-weight for individual material types and forms. The information in this table is derived from field studies, a literature search, and mail survey. Tables 1, 2, 3, and 4 present the results of various data collection efforts from which data for Table 5 were selected. Selection and incorporation of data from Tables 1, 2, 3, and 4 into the master table (i.e., Table 5) was based on the following hierarchy in descending order of reliability: field studies, literature search and telephone communication, and mail survey.

At the top of the hierarchy of selection is the use of field study data. Field studies were conducted under controlled conditions and where possible were replicated in order to provide statistically valid densities of materials. These studies also allowed, in some cases, the selection of sub-groups for measurements within a specific material type. For example, previously published densities for whole glass containers do not distinguish density of containers as a function of color. The field studies conducted for this project enabled this distinction to be studied.

In those cases where collection of field data for field data for certain material types or forms was not feasible, data was utilized from the literature survey and telephone communication where such data were available and judged to be reliable.

For this study the least reliable density data were judged to be supplied by the mail survey. Confirmation of measurement data and other uncertainties are reasons for relegating the density results of the mail survey to the lowest level of the hierarchy of data reliability. Lacking data from field measurements or from the literature search, data was used from the mail survey where the data were judged by CalRecovery to be reliable.

Table 5. Densities and Conversion Factors for Various Material Types

Material Type	Form a)	Special Notes b)	California Field Studies			Conversion Factors from Literature Review			Out of State Field Studies			California Mail Survey Results		
			Conversion Factors			Conversion Factors			Conversion Factors			Conversion Factors		
			lb/cu yd	cu yd	Tons	lb/cu yd	cu yd	Tons	lb/cu yd	cu yd	Tons	lb/cu yd	cu yd	Tons
PAPER														
Old Corrugated Cardboard/ flattened boxes	loose		50.08	39.93	0.03									
Old Corrugated Cardboard/ whole boxes	loose		16.64	120.19	0.01									
Old Corrugated Cardboard/ recycling center	baled	73"x42"x32"	713.00	2.81	0.36									
Old Corrugated Cardboard/ resource recovery facility	baled	87"x40"x29"	742.00	2.70	0.37									
Old Corrugated Cardboard Kraft (Brown) Bags/Paper	baled low density	48"x42"x32"												
Brown Paper Bags	baled low density	69"x42"x40"												
Mixed Paper	loose		34.43	58.09	0.02									
Mixed Paper/supermix	loose		635.00	3.15	0.32									
Newspaper	baled	76"x38"x34"	748.00	2.67	0.37									
Newspaper: w/o Inserts	loose	80"x42"x32"	322.77	6.20	0.16									
Newspaper	low compaction truck													
Mags. Glossy/in.coated	baled high density	3'x4'x5'												
Glossy Inserts	loose		570.37	3.51	0.29									
High Grade White Ledger	baled	76"x34"x38"	644.00	3.11	0.32									
High Grade Ledger/w/o CPO	loose		363.51	5.50	0.18									
Books/hardback	loose		529.29	3.78	0.26									
Books/paperback	loose		427.50	4.68	0.21									
Telephone Directories/books	whole	stacked												
Computer Printout	loose		519.40	3.85	0.26									
Computer Printout	baled	75"x40"x30"	578.00	3.46	0.29									
Other Paper/trims (white fly)	baled high density	84"x32'42"												
Other Paper/trims (white fly)	baled high density	68"x45"x28"												
Bleached HWD & SWD Paper	baled high density	35"x30"x17"												
Paperboard/Boxboard/Chipboard	whole		21.50	93.02	0.01									
PLASTIC														
HDPE/colored (black nursery pots)	baled		573.00	3.49	0.29									
HDPE/milk,water	whole	81"x44"x31"	22.10	90.50	0.01									
HDPE/mix color	whole		47.05	42.50	0.02									
HDPE/natural	baled	91"x43"x32"	578.00	3.47	0.29									
HDPE (mixed colored)	baled	84"x44"x32"	511.00	3.91	0.26									
HDPE (mixed colored)	pelletized	3 to 4 cu in.												

a) Refer to Appendix B for an explanation of processed and unprocessed forms

b) < = less than

Table 5. Densities and Conversion Factors for Various Material Types (Continued)

Material Type	Form a)	Special Notes b)	California Field Studies				Conversion Factors from Literature Review				Out of State Field Studies				California Mail Survey Results			
			Conversion Factors		Conversion Factors		Conversion Factors		Conversion Factors		Conversion Factors		Conversion Factors		Conversion Factors			
			lb/cu yd	cu yd to Tons	cu yd to Tons	Tons to cu yd	lb/cu yd	cu yd to Tons	Tons to cu yd	Tons to cu yd	lb/cu yd	cu yd to Tons	Tons to cu yd	Tons to cu yd	lb/cu yd	cu yd to Tons	Tons to cu yd	Tons to cu yd
PET	baled	92"x43"x32"	414.00	4.83	0.21													
PET/clear w/o redemp	baled	79"x43"x32"	443.00	4.51	0.22													
PET/CRV	whole		34.58	57.84	0.02													
PET/mixed	whole		43.30	46.19	0.02													
PET	granulated	1/2"																
PVC	loose		22.55	88.69	0.01													
Film Plastic/mixed	loose		49.76	40.19	0.02													
Other Plastic (SPI codes #3-7)	whole																	
LDPE Film Plastics	semi-compacted	assorted bags																
HDPE Film Plastics	semi-compacted	assorted bags																
Polyethylene/rigid	whole	stacked sheets																
Polyethylene/blown formed foam	loose		9.62	207.87	0.00													
Styrofoam/kernels	loose		6.27	318.87	0.00													
Polypropylene/film	packed	can liners																
Polypropylene/strap	packed, coiled																	
GLASS																		
Other Non-Recyclable	size reduced	plate glass window, <4'																
Glass/clear CRV	whole		466.49	4.29	0.23													
Glass/clear non-CRV	whole		437.77	4.57	0.22													
Glass/green	whole		456.71	4.38	0.23													
Glass/mix brown	whole		439.58	4.55	0.22													
Glass/mix clear	whole		478.26	4.20	0.24													
Glass/mix color	size reduced	<2'	1867.75	1.07	0.93													
Cal Redemp. Value	size reduced	5/8"																
Other Recyclable	size reduced	5/8"																
METAL																		
Aluminum Foil	loose		48.10	41.60	0.02													
Aluminum Foil	baled	65"x42"x29"	188.00	10.64	0.09													
Aluminum Cans	loose	uncrushed & crushed mix	91.40	21.88	0.05													
Aluminum Cans	baled	82"x41"x31"	399.00	5.01	0.20													
Aluminum Cans	uncrushed																	
Aluminum Cans	shredded	2"																
Aluminum Scrap	cubed	34"x24"x20"	424.00	4.72	0.21													
Aluminum Scrap	whole																	

a) Refer to Appendix B for an explanation of processed and unprocessed forms

b) < = less than

Table 5. Densities and Conversion Factors for Various Material Types (Continued)

Material Type	Form a)	Special Notes b)	California Field Studies			Conversion Factors from Literature Review			Out of State Field Studies			California Mail Survey Results		
			Conversion Factors		Conversion Factors		Conversion Factors		Conversion Factors		Conversion Factors		Conversion Factors	
			lb/cu yd	Tons to cu yd to cu yd Tons	lb/cu yd	Tons to cu yd to cu yd Tons	lb/cu yd	Tons to cu yd to cu yd Tons	lb/cu yd	Tons to cu yd to cu yd Tons	lb/cu yd	Tons to cu yd to cu yd Tons	lb/cu yd	Tons to cu yd to cu yd Tons
BI-Metal Containers	uncrushed		144.32	13.96	0.07			141.38	14.15	0.07				
Ferrous Food & Beverage Containers	loose		2093.00	0.96	1.05								337.50	5.93
Ferrous Food & Beverage Containers	cubed	29"x21"x24"	906.43	2.21	0.45								210.94	9.48
Brass/scrap	whole	<12"				1603.84	1.25	0.80						
Lead Scrap	whole					1093.52	1.83	0.55						
Copper Scrap	whole													
Copper Wire	whole													
Copper Pipe	whole													
Copper Fittings	loose													
White Goods	cubed	30"x22"x23"	1907.00	1.05	0.95			1047.62	1.91	0.52				
Dishwashers	whole					234.00	8.55	0.12						
Dryers	whole					224.00	8.93	0.11						
Refrigerators/freezers	whole					198.00	10.10	0.10						
Washers	whole					321.00	6.23	0.16						
Stoves/ovens	whole					300.00	6.67	0.15						
YARD WASTE														
Leaves/dry	loose		343.70	5.82	0.17									
Grass/clipping fresh	loose		280.22	7.14	0.14								527.00	3.80
Prunings	shredded	2"												
Prunings/dry	loose	<4"	36.90	54.20	0.02									
Prunings/green	loose	<4"	46.69	42.83	0.02									
Large Limbs & Stumps	loose	>4"				1060.00	1.85	0.54						
Garden Debris/flowers, plants	loose		182.81	10.94	0.09									
Pine Needles	loose	dry	74.42	26.88	0.04									
OTHER ORGANICS														
FOOD WASTE														
Produce Waste/cantalopes	loose												1000.00	2.00
Produce Waste/mixed fruit	loose												1131.00	1.77
Produce Waste/vegetable	loose												909.00	2.20
Produce Waste/mixed	loose													
MULCH/COMPOST														
Mulch/cedar	loose		381.96	5.24	0.19									
Mulch/redwood	loose	coarse	187.50	10.67	0.09									
Mulch/redwood	loose	fine	277.50	7.21	0.14									
Bark/fir	size reduced	1/4"	426.96	4.68	0.21									

a) Refer to Appendix B for an explanation of processed and unprocessed forms

b) < = less than

Table 5. Densities and Conversion Factors for Various Material Types (Continued)

Material Type	Form a)	Special Notes b)	California Field Studies			Conversion Factors from Literature Review			Out of State Field Studies			California Mail Survey Results		
			Conversion Factors		Conversion Factors		Conversion Factors		Conversion Factors		Conversion Factors		Conversion Factors	
			lb/cu yd	cu yd to Tons	Tons to cu yd	cu yd to Tons	lb/cu yd c)	cu yd to Tons	Tons to cu yd	Tons	lb/cu yd	cu yd to Tons	Tons to cu yd	Tons
Bark/tir	size reduced	3/4"	438.75	4.56	0.22									
Bark/tir	size reduced	2"	492.86	4.06	0.25									
Wood Chips	shredded	2"												
Compost	loose		463.39	4.32	0.23	1400.00	1.43	0.70					240.00	8.33
Compost/MSW	loose	40-50% moisture												
Compost/sludge	loose	unscreened				474.00	4.20	0.24	1739.75	1.15	0.87			
Compost/yard waste	loose													
Compost/mushroom	loose		827.68	2.42	0.41									
TIRES														
Tires/auto	whole	stack of 3 tires							221.57	9.03	0.11			
Tires/truck	whole	Individual tire							476.00	4.20	0.24			
Radial	whole	Individual tire							362.00	5.52	0.18			
Bias	whole	bias ply				318.00	NA d)	NA						
Tires/heavy equip.	whole	Individual tire												
	loose	weight only				1200.00	1.67	0.60						
Rubber Products														
Furniture	whole					166.00	12.05	0.08						
Pallets	whole	4/sample	200.98	9.95	0.10									
Saw dust	loose		375.00	5.33	0.19									
Wood scrap	loose	<2'	329.53	6.07	0.16									
Particle board	loose		425.14	4.70	0.21									
Shavings	loose					440.00	4.55	0.22						
Roofing/shake shingle	bundle		435.30	4.59	0.22									
Plywood	sheet	2'x4'	776.30	2.58	0.39									
AG CROP RESIDUE														
Field Residues														
Spent barley	loose					450.00	4.44	0.23						
Corn silage	loose					480.00	4.17	0.24						
Dried corn stalks	loose					30.00	66.67	0.02						
Almond shell/hulls	loose		642.86	3.11	0.32									

a) Refer to Appendix B for an explanation of processed and unprocessed forms
 b) < = less than
 c) Except for individual items (e.g., each) in which case the units are pounds (lb).
 d) NA means not applicable because data are reported on a unit basis.

Table 5. Densities and Conversion Factors for Various Material Types (Continued)

Material Type	Form a)	Special Notes b)	California Field Studies			Conversion Factors from Literature Review			Out of State Field Studies			California Mail Survey Results		
			Conversion Factors		Conversion Factors		Conversion Factors		Conversion Factors		Conversion Factors		Conversion Factors	
			lb/cu yd	cu yd to Tons	lb/cu yd	cu yd to Tons	lb/cu yd	cu yd to Tons	lb/cu yd	cu yd to Tons	lb/cu yd	cu yd to Tons	lb/cu yd	cu yd to Tons
Rice Hulls	loose				220.00	9.09	0.11							
Straw	loose				60.00	33.33	0.03							
Prunings	loose	<4"	46.69	42.83	0.02									
Cannery Waste	loose													
Beet pulp	loose													
Tomato pumice	loose	wet	827.14	2.42	0.41	350.00	5.71	0.18						
Grape pumice	loose	wet	1240.18	1.61	0.62									
Grape pumice	loose	dry	781.61	2.56	0.39									
MANURE														
Poultry														
Ricca hen aged	loose	wet				1406.00	1.42	0.70						
Ricca hen fresh	loose	wet				1376.00	1.45	0.69						
Turkey	loose					734.00	2.72	0.37						
Broiler	loose	dry				756.00	2.65	0.38						
Hen	loose	wet				1796.00	1.11	0.90						
Livestock														
Horse Manure	loose	w/ wood chips				1626.00	1.23	0.81	1252.00	1.61	0.63			
Cattle	loose													
TEXTILES														
Carpet & Padding	loose		64.40	23.70	0.04									
Scrap Leather	semi-compacted	1/8"x7"x33" pieces							243.00	6.23	0.12			
Scrap Leather	semi-compacted	1/8"x6"x18" pieces							303.00	6.60	0.15			
Scrap Leather	semi-compacted	1/8"x6"x18" pieces-flat							470.00	4.26	0.24			
Leather Remnants	semi-compacted	apron leather							383.60	5.21	0.19			
Leather Remnants	semi-compacted	shoe leather							363.40	5.50	0.18			
Leather Remnants	semi-compacted	hide scraps							514.90	3.66	0.26			
Shoes/men's	loose								224.00	8.93	0.11			
Used Clothes/winter coats	loose								241.00	8.30	0.12			
Used Clothes/jeans	loose								285.00	7.02	0.14			
Used Clothes/T-shirts	loose								260.00	7.69	0.13			
Used Clothes/mixed	loose								225.00	8.89	0.11			
Used Clothing	compacted					540.00	3.70	0.27						

a) Refer to Appendix B for an explanation of processed and unprocessed forms

b) < = less than

Table 5. Densities and Conversion Factors for Various Material Types (Continued)

Material Type	Form a)	Special Notes b)	California Field Studies			Conversion Factors from Literature Review			Out of State Field Studies			California Mail Survey Results				
			Conversion Factors		lb/cu yd	Conversion Factors		lb/cu yd	Conversion Factors		lb/cu yd	Conversion Factors		lb/cu yd	Conversion Factors	
			Tons to cu yd	cu yd to Tons		Tons to cu yd	cu yd to Tons		Tons to cu yd	cu yd to Tons		Tons to cu yd	cu yd to Tons			
OTHER WASTES																
INERT SOLIDS																
Rock	loose	2-12"	1325.89	1.51	0.66											
Rock/red lava	loose	5/16"	1855.18	1.08	0.93					2570.96	0.78	1.29				
Concrete Scrap	loose	<8"				3024.00	0.66	1.51								
Brick	whole															
Brick/red (broken)	loose	<8"	1614.11	1.24	0.81											
Ceramic Tile	loose	6"x6"	1213.93	1.65	0.61											
Sand	loose		2441.25	0.82	1.22					2600.00	0.77	1.30				
Contaminated Soil	loose		2391.96	0.84	1.20											
Soil/sandy loam	loose		2385.54	0.84	1.19											
Soil/via self haul	loose															
Fines	loose															
Asphalt/paving	crushed															
Asphalt/tar roofing	loose		418.53	4.78	0.21											
Asphalt/shingles comp	loose															
Gravel	loose															
Stone/crushed	loose															
Sheetrock Scrap	size reduced															
Sheetrock Scrap	loose	<2'	393.57	5.08	0.20											
Fiberglass Insulation	loose									17.00	117.65	0.01				
Soiled Disposable Diapers	loose		540.00	3.70	0.27											
Aseptic Packaging	whole		56.70	35.27	0.02											
Televisions	whole									343.00	5.83	0.17				
Stereo Equipment	whole									763.00	2.62	0.38				
Stuffed Furniture	whole									80.00	25.00	0.04				
Empty Discarded HHW Containers	whole															
Antifreeze	liquid		117.26	17.06	0.06					1653.00	1.21	0.83				
Auto Batteries	whole															
Auto Oil Filters	loose	4/sample	3027.18	0.66	1.51											
Enamel Paint	liquid		834.40	2.40	0.42											
Latex Paint	liquid															
Flammable Liquids	liquid									1653.00	1.21	0.83				
Flammable Liquids	liquid									1836.00	1.09	0.92				
Aerosol Cans										1653.00	1.21	0.83				
Oxidizers										550.00	3.64	0.28				
										918.00	2.18	0.46				
										92.00	21.74	0.05				

a) Refer to Appendix B for an explanation of processed and unprocessed forms

b) < = less than

Table 5. Details and Conversion Factors for Various Material Types (Continued)

Material Type	Form a)	Special Notes b)	California Field Studies			Conversion Factors from Literature Review			Out of State Field Studies			California Mail Survey Results			
			Conversion Factors			Conversion Factors			Conversion Factors			Conversion Factors			
			lb/cu yd	cu yd	Tons	lb/cu yd c)	cu yd	Tons	lb/cu yd	cu yd	Tons	lb/cu yd	cu yd	Tons	
Poisons															
Waste Oil															
SPECIAL WASTES															
Ash/Inchelorator		50% solids				1350.00	1.48	0.68							
Ash/Inchelorator		15% water				1957.00	1.02	0.98							
Ash/wood		50% solids				1100.00	1.62	0.55							
Ash/other		dry				1110.00	1.80	0.56							
Bechouse		*				810.00	2.47	0.41							
Sewage Sludge/dewatered		20.4% solids	1293.75	1.55	0.65										
Sewage Sludge/dewatered		85.5% solids	1935.54	1.03	0.97										
Sludge/chem fix		55% solids				2025.00	0.99	1.01							
Industrial Sludge/apple waste		41% solids				1411.00	1.42	0.71							
Industrial Sludge/papermill		34.38% solids				1425.00	1.40	0.71							
Industrial Sludge/dewatered		50% solids													
Asbestos Bags		landfill high compaction													
Auto Shredder Fluff		semi-compacted loose				376.50	5.30	0.19							
Auto Bodies		baled				800.00	2.50	0.40							
Auto Bodies		flattened				1215.00	1.65	0.61							
Auto Bodies		compacted				579.20	3.45	0.29							
Cement Kiln Dust		loose				450.00	4.44	0.23							
Slag		loose				1404.00	1.42	0.70							
Slag		broken				2970.00	0.67	1.49							
Slag		crushed				1998.00	1.00	1.00							
Slag/furnace		granulated				1620.00	1.23	0.61							
Slag/screenings		loose				2495.00	0.80	1.25							
Dead Animals/small		each				20.00	NA d)	NA							
Dead Animals/arge		each				1150.00	NA	NA							
Dead Animals/turkey		bulk				600.00	3.33	0.30							
Transformer/100 kva		whole				1798.00	1.11	0.90							
Transformer/15 kva		whole				1008.00	1.98	0.50							
Transformer/167 kva		whole				1828.00	1.09	0.91							
Transformer/25 kva		whole				1098.00	1.82	0.55							
Transformer/37.5 kva		whole				1254.00	1.59	0.63							
Transformer/50 kva		whole				1328.00	1.51	0.66							
Transformer/75 kva		whole				1385.00	1.44	0.69							
e) Refer to Appendix B for an explanation of processed and unprocessed forms															
b) < = less than															
c) Except for individual items (e.g. each) in which case the units are pounds (lb).															
d) NA means not applicable because data are reported on a unit basis.															
			1500.00	1.33	0.75										

Table 5. Denitties and Conversion Factors for Various Material Types (Continued)

Material Type	Form a)	Special Notes b)	California Field Studies		Conversion Factors from Literature Review			Out of State Field Studies		California Mail Survey Results	
			lb/cu yd	cu yd to Tons	lb/cu yd	Tons to cu yd to Tons	lb/cu yd	Tons to cu yd to Tons	lb/cu yd	cu yd to Tons	
Street Sweepings	loose		1145.36	1.75	0.57						
Drilling Mud		25% moisture				2222.00	0.90	1.11			
Septic Tank Pumpings						1855.56	1.21	0.83			
Chemical Toilet Wastes						1655.56	1.21	0.83			
Grease Trap Pumpings						1594.90	1.25	0.80			
Intact Red Bags of Treated Medical Waste						168.15	12.04	0.08			
Drinking Water/wastewater treatment residue (Diatomaceous Earth)		85% moisture at dry	987.00	2.07	0.48	479.80	4.17	0.24			

a) Refer to Appendix B for an explanation of processed and unprocessed forms
 b) < = less than